THE

IMPROVED

STEAM-ENGINE.

[Price Two Shillings.]

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AN
ACCOUNT AND DESCRIPTION
OF AN
IMPROVED
STEAM-ENGINE:

Which will, with the ſame Quantity of Fuel, and in an equal Space of Time, raiſe above double the Quantity of Water than any Lever Engine of the ſame Dimenſions,

ILLUSTRATED WITH A COPPER-PLATE,

By N. D. FALCK, M. D.

LONDON:
Printed for B. LAW in Ave Maria Lane,
M.DCC.LXXVI,

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G.R. III
BRITISH MUSEUM

PREFACE.

WHEN *the preſent plan was confirmed by experiments, I thought it my duty to make it public as ſoon as poſſible; not only in hopes of its meeting with a favourable reception, but when put in practice, that it might prove of advantage to ſociety.*

But however eligible the plan may appear to the diſcerning judicious, yet a working model may be neceſſary to remove every ariſing doubt, and prove its ſuperior utility by abſolute facts. The expences would be very inconſiderable in compariſon to the many advantages; but ſubmitting this propoſal to mature conſideration, I have only to add, that I ſhall ever be ready to put it in execution, and to give an exact delineation of every part of the whole engine in true proportion, with requiſite remarks *on the operation; of which this is only offered as a ſketch, to convey a general idea of the improvement. And to make this engine more complete, I have a plan of a new conſtructed pump to offer, which will have ſingular advantages over every kind of pump I know of, for raiſing great ſtreams of water.*

To conclude, I am happy in the reflection of having many improvements and original inventions of great importance to ſociety, and which I ſhall always be ready to diſcloſe to the world, before I leave it; having no ambition beyond that of rendering my life, by every opportunity in my power, uſeful to mankind.

N. D. FALCK.

P. S. *Letters addreſſed for Dr. Falck, to the care of Mr. B. Law in Ave Maria Lane, will ſafely come to hand, and be duly attended to.*

BOOKS *written by* N. D. FALCK, M. D. *and publiſhed by* B. LAW, *in Ave Maria Lane.*

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AN ACCOUNT OF THE PRINCIPLES AND MECHANISM OF THE IMPROVED STEAM-ENGINE,

By N. D. FALCK, M. D.

BEFORE I enter upon the deſcription, I ſhall barely mention the advantages of this improved engine above thoſe now in common uſe, which are the following;

I. This engine will raiſe more than double the quantity of water that can be raiſed by any other common engine of the ſame dimenſions, in an equal ſpace of time, and with the ſame quantity of fuel,

II. The movement of this engine will always be uniform, acting continually with the ſame degree of force; and as the mechaniſm is more compact, and the parts ſtronger, it will neither be ſo ſubject to be out of repair from attrition, nor liable to accidents, as engines upon the common conſtruction are.

III. The improvement can be adapted to the Steam-Engines now in uſe; by which (without any conſiderable expence) thoſe engines, with the ſame quantity of fuel, may be rendered capable of raiſing more than double the quantity of water in the ſame ſpace of time they now do.

IV. The mechaniſm of this improved Steam-Engine may be adapted to many other purpoſes beſides raiſing of water; as it may be applied to forge, ſtamp, flat, grind, and to many other powerful operations, and can be erected with advantage where neither wind nor water-mills are practicable.

But in order to conceive theſe advantages ariſing from the improvement of this engine, it is requiſite that the mechaniſm of thoſe now in uſe, and the improvements offered by others, ſhould previouſly be underſtood: but firſt it may not be improper to enquire who was the original inventor.

The original author of this great invention of raiſing of water by ſteam, was indiſputably that noble and ever memorable genius the Marquis of Worceſter, who publiſhed his thoughts on that ſubject in his *Century* of *Inventions* in the year 1668. It was ſome time afterwards vigorouſly proſecuted by Mr. Savery *; and at the very time Mr. Savery was employed to complete his engine, Dr. Papinus † of Marburg, and Monſ. Amontons of Paris, were engaged to the ſame purpoſe; each claiming the originality of the invention, though poſſibly all were equally indebted to the abovementioned ſmall though valuable book of the Marquis. On compariſon however it appeared, that Mr. Savery had rendered his engine much more complete than that of Dr. Papinus; but Monſ. Amontons died before he had the ſatisfaction of completing his engine, which he termed a fire-mill, as its firſt movement was propoſed to be a wheel, to be driven by fire

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* It is ſaid that Mr. Savery bought up all he could find of this ſmall though valuable book, with an intent to ſecure the invention to himſelf.

† This gentleman publiſhed a ſmall work in the year 1707, intitled, Ars nova ad aquam ignis adminiculo efficaciſſime elevandam.

or ſteam*. Mr. Savery obtained a Patent from Parliament for his engine for the term of twenty-one years.

This engine of Mr. Savery's conſtruction being the firſt of its kind, conſiſted firſt, of a ſtrong boiler, forcing the ſteam by means of a pipe into a cylindrical veſſel, having a communication by means of a pipe and valve with the water that was to be raiſed; and from the ſame veſſel aſcended another pipe to the height the water was to riſe. When the veſſel was filled with ſteam from the boiler, a cock in the ſteam pipe was turned to prevent a farther admiſſion of ſteam, and another cock was turned which admitted cold water to be injected into the ſteam; by which, from the refrigeration and condenſation of the ſteam, a vacuum enſued; and the water beneath being preſſed by the atmoſphere, was forced into the cylinder to occupy the ſpace which juſt before was ſteam. When the cylinder was filled with water the ſteam was again admitted, and the water, ſince it was prevented a return by the valve in the pipe, was forced by the aſcending pipe to its required height, and prevented from returning by a valve till the veſſel was full of ſteam; when again the ſteam cock was turned, cold water injected, and a new operation repeated.

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* This fire-mill perhaps was upon the ſame principles as that of Mr. Watt, which will hereafter be deſcribed.

Ingenious as this engine was, yet it laboured under many inconveniencies in practice, which greatly limited its power. For in the firſt place, it was found very difficult to make a boiler of any magnitude ſtrong enough to reſiſt ſo violent a ſteam as the engine required, to force the water out of the cylinder to the proper height; and ſecondly, the ſteam cylinder could not exceed thirty feet from the level of the water that was to be raiſed, as thirty-three feet is the extent of a column of water to counterpoiſe the atmoſphere. Mr, Newcomen therefore ſtept in before the Patent was expired; and in the year 1705 erected his firſt engine, in which all the former inconveniences were not only remedied, but it was conſtructed on a plan quite different; which hitherto has remained in common practice. It is this laſt kind of engine, on which the improvement is here propoſed to be made; I ſhall therefore deſcribe it as far as relates to the principles of the operation.

This engine, termed in diſtinction from the former, Newcomen's Lever-Steam or Fire-Engine, conſiſts firſt, of a large boiler, filled about one-third with water, to leave ſufficient room for the ſteam, which is not forced into a greater ſtrength than the common atmoſphere; and to keep it continually to this degree of ſtrength, the boiler is provided with a pipe, in which is a clack, called a puppit clack, loaded in proportion to five pounds per ſquare inch, through which the ſteam is let to ruſh when it exceeds this ſtrength during the time of the operation.

2dly, On the dome of this boiler is fixed a hollow ſtrong cylinder, of a true round bore, and ſmooth ſurface within; and as on that part the power of the engine depends, it is firmly ſecured to the building by ſtrong beams, to render it immovable.

3dly, In this cylinder is a piſton, fitted exactly to the bore perfectly air-tight, but of a ſmall depth, in order that it may move eaſily up and down.

4thly, In the dome of the boiler is a ſteam valve, which alternately admits the ſteam into the cylinder, and confines it again to the boiler; and as on that valve the operation principally depends, it is termed the regulator; and by the mechaniſm of the engine, is opened and ſhut in the preciſe time of the piſton's aſcending and deſcending to its proper poſition in the cylinder.

5thly, The cylinder has a pipe by which cold water is injected when it is full of ſteam, and the piſton is raiſed up to the top; by which the ſpace occupied by the ſteam is rendered a vacuum, into which the piſton is forced down by the atmoſphere. It has an educting pipe, through which the injected water and the condenſed ſteam are emitted; and thirdly a valve, called the ſnift, through which the ſuperfluous air is let out when the regulator is opened.

6thly, The engine has a ſtrong lever, arched at each end, moving in the middle on an axis or fulcrum. To the one end of this lever is ſuſpended the piſton of

the

the ſteam cylinder, and to the other end the rod which moves the buckets of the pump; ſo that the ſteam-piſton and pump-bucket keep continually in an oppoſite alternate aſcending and deſcending motion. But in order to draw up the piſton in the cylinder (to effect which the ſteam is not ſufficient) and to preſs down the bucket in the pump, a conſiderable weight is added to the pump rods, which frequently amounts to near half of the power of the engine.

7thly, To the lever is affixed mechaniſm, which, as it moves up and down, cauſes the regulator to open and ſhut alternately. At a very ſmall interval a cock opens alſo, by which cold water is injected into the cylinder, and this too ſhuts alternately, that is, when the piſton is at the top of the cylinder (or nearly ſo); and at the ſame time the regulator is ſhut, the cock of the cold water opens, and cold water is injected into the cylinder all the time the piſton is forced down; but when near the bottom, the mechaniſm ſhuts again the injecting cock, and immediately the regulator opens for a freſh admiſſion of the ſteam.

Theſe principal parts being underſtood, the engine performs the operation thus:

The ſteam of the boiling water being by the opening of the regulator admitted into the cylinder, the piſton is lifted up by the lever by means of the overbalancing weight added on the other end of the lever; when the piſton is nearly arrived at the top, and the cylinder is full of ſteam, the regulator ſhuts immediately, the cold water cock opens, and cold water is injected, which condenſes and refrigerates the ſteam, ſo that the whole ſpace becomes nearly a vacuum, and the piſton is forced down into this vacuum by the atmoſphere, with a force equal to ſeven or eight pounds for every ſquare inch of the area of the piſton, which by means of the lever pulls up the bucket in the pump and raiſes the water.

When the piſton is forced down to the bottom of the cylinder by the preſſing atmoſphere, the cock by which the cold water was injected is ſhut; the regulator for admiſſion of the ſteam opens; by the ſudden force of which, the air injected by the cold water is forced through the ſniſt, the water through the eduction pipe, and the piſton is again admitted to riſe; which, when arrived to the top of the cylinder, the regulator ſhuts, cold water is injected, and another powerful ſtroke enſues, which is repeated about nine or ten times in a minute.

Such is the conſtruction of Mr. Newcomen's Lever-Steam-Engine, which hitherto for theſe ſeventy years has remained in common uſe, without any conſiderable improvement; till of late Mr. Watt, engineer, has obtained a Patent from Parliament for an improvement, whereby he purpoſes to increaſe the power at each ſtroke of the engine by the following method, in Mr. Watt's own words: "The cylinder or ſteam-veſſel of this "engine is ſhut at bottom and open at "top, as uſual, and is included in a caſe "of wood, or metal covered with mate-"rials which tranſmit heat ſlowly. This "caſe is at a little diſtance from the cy-"linder, and is ſhut at both ends; the "cover has a hole in it through which "the piſton rod ſlides, and the bottom "has another by which the ſteam from "the boiler has always free entrance "into this caſe or outer cylinder, and "by the interſtice between the two cy-

“ linders has acceſs to the upper ſide of “ the piſton.

“ To the bottom of the inner cylinder “ is joined a pipe, with a cock, which is “ opened and ſhut when neceſſary, and “ forms a paſſage to another veſſel called “ a condenſer, made of thin metal. “ This veſſel is immerſed in cold water, “ and is contrived in ſuch a manner as “ to expoſe a very great ſurface externally “ to the water, and internally to the “ ſteam. It is alſo made air-tight, and “ has pumps wrought by the engine, “ which keep it always exhauſted of air “ and water.

“ Both the cylinders being filled with “ ſteam, the paſſage is opened from the “ inner one to the condenſer into which “ the ſteam ruſhes with violence by its “ elaſticity, becauſe that veſſel is ex- “ hauſted; but it no ſooner enters it,

" than coming into contact with the
" cold matter of the condenſer, it is re-
" duced to water, and the vacuum ſtill
" remaining, the ſteam continues to ruſh
" in until the inner cylinder below the
" piſton is left empty. The ſteam
" which is above the piſton ceaſing to
" be counteracted by that which was
" below it, acts upon the piſton, and
" forces it to deſcend to the bottom of
" the cylinder, and ſo raiſes the bucket
" of the pump by means of the lever.
" The paſſage between the inner cylin-
" der and the condenſer is then ſhut,
" and another paſſage is opened, which
" permits the ſteam to paſs from the
" outer cylinder, or from the boiler into
" the inner cylinder under the piſton,
" and then the ſuperior weight of the
" bucket and pump rods pulls down the
" outer end of the lever or great beam,
" and raiſes the piſton, which is ſuſ-

" pended to the inner end of the ſame
" beam.

" The advantages that accrue from
" this conſtruction are, firſt, that the
" cylinder being ſurrounded with the
" ſteam from the boiler, is kept always
" uniformly as hot as the ſteam itſelf,
" and is therefore incapable of deſtroying
" any part of the ſteam which ſhould fill
" it, as the common engines do. Se-
" condly, the condenſer being kept al-
" ways as cold as water can be procured,
" and colder than the point at which it
" boils in vacuo, the ſteam is perfectly
" condenſed, and does not oppoſe the
" deſcent of the piſton, which is there-
" fore forced down by the full power of
" the ſteam from the boiler, which is
" ſomewhat greater than that of the at-
" moſphere.

“ In the common fire engines, when “ they are loaded to ſeven pounds upon “ the inch, and are of a middle ſize, “ the quantity of ſteam which is con- “ denſed in reſtoring to the cylinder the “ heat which it had been deprived of by “ the former injection of cold water, is “ about one full of the cylinder, be- “ ſides what really it required to fill that “ veſſel; ſo that twice the full of the “ cylinder is employed to make it raiſe “ a column of water equal to ſeven “ pounds for each ſquare inch of the “ piſton: or, to take it more ſimply, a “ cubic foot of ſteam raiſes a cubic foot “ of water about eight feet high, be- “ ſides overcoming the friction of the “ engine, and the reſiſtance of the water “ to motion.

“ In the improved engine, about one “ full and a fourth of the cylinder is re- “ quired to fill it, becauſe the ſteam is

" one-fourth more denſe than in the " common engine. This engine raiſes " a load equal to twelve pounds and a " half upon the ſquare inch of the piſton, " and each cubic foot of ſteam of " the denſity of the atmoſphere raiſes " one cubic foot of water twenty-two " feet high.—Theſe are facts (ſays he) " proved by the actual performance of " this engine, and that of the very beſt " of many common engines which have " been accurately examined; moſt of " the common engines do not raiſe a " foot of water ſix feet high by a foot " of ſteam."

But though ever ready to pay the reſpect due to every ingenious man, I muſt beg leave to differ from Mr. Watt as to the many advantages he promiſes from his invention; being very apprehenſive, that when really put into execution, it will prove perhaps inferior to the old method he has with ſo much labor and expence ſtudied to amend.

In the firſt place, the improvement muſt be exceedingly complicated and expenſive; and, what is worſe, very ſubject to be out of repair. Admit this however not to be an object, I am ſtill of opinion that Mr. Watt is greatly miſtaken, in ſuppoſing that the preſſure of the ſteam on the piſton will be ſo much greater than the common atmoſphere, and that the vacuum produced by his condenſer will be more perfect, than that produced by the injection of cold water into the cylinder.

But ſuppoſe the latter ſhould be ſo, the exhauſting of the condenſer muſt undoubtedly greatly diminiſh the force of the engine; and however he may flatter himſelf that he has diſcovered more properties of air or ſteam than his predeceſſors, if he will advert candidly to experiments of that kind he will moſt certainly find, that the ſudden refrigeration of cold water admitted into the ſteam, will make a much more perfect temporary vacuum than one produced by exhauſting, where the cylinder retains the ſame degree of heat. There are many other objections to this complicated addition which I could mention, from which I fear that the invention, if put in execution, will be far from continuing in practice, or produce, during its continuance, any advantage to the owners of engines, or even to the inventor. But as Mr. Watt has not in his propoſals given the plan at large, and as I have not been an eye-witneſs of the operation of his experiments, I can judge only from his own words; and at the ſame time I ſhall be very happy to be convinced to the contrary by ocular demonſtration.

“ The ſecond ſpecies of the improved
“ engines (of Mr. Watt) is a machine
“ which produces a circulating or rota-
“ tive motion by the immediate action
“ of ſteam; it conſiſts of a wheel placed
“ vertically, which has a hollow channel
“ round its circumference as if a tube
“ were bent into a circle, and its two
“ ends joined together; in this channel
“ are placed three valves, made ſo as to
“ permit any body to go round the chan-
“ nel in one direction only, but ſo as to
“ prevent even the paſſage of ſteam in
“ the contrary direction. There is alſo
“ a weight fitted to this channel, ſo as to
“ be ſteam-tight, but capable of moving
“ eaſily in it, and of paſſing through
“ the valves when they are open; the
“ axis of the wheel is perforated longi-
“ tudinally by three holes, which com-
“ municate with three diviſions of the
“ channel, by as many pipes which enter
“ the channel near the back of the

“ valves. By means of a hole in a fixed
“ piece of metal, which is accurately
“ fitted to the end of the axis, it is con-
“ trived that one of theſe pipes ſhall re-
“ ceive ſteam from the boiler, while
“ another pipe diſcharges the ſteam into
“ the condenſer after it has done its of-
“ fice, through another hole which is in
“ the ſame fixed piece of metal; ſo that
“ as the holes in the end of the axis,
“ by the motion of the wheel, come op-
“ poſite to one or other of the two holes
“ in the fixed piece of metal, they re-
“ ceive or diſcharge ſteam accordingly.

“ When the wheel is at reſt, the
“ weight naturally remains at the loweſt
“ part of it; but when the ſteam is ad-
“ mitted, it acts equally upon the
“ weight and the valve, and forces them
“ aſunder; the weight is conſequently
“ raiſed towards the oppoſite ſide of the
“ wheel from the valve, until its gra-

" vity, acting upon the valve through
" the medium of the ſteam, becomes
" greater than the reſiſtance or load the
" wheel has to overcome. As ſoon as
" that is the caſe the weight becomes
" ſtationary, and the valve recedes from
" it; and conſequently the wheel, to
" which the valve is attached, begins to
" turn round in the contrary direction
" to that in which the weight had been
" raiſed; when a pipe paſſes the upper
" diameter of the wheel, it diſcharges
" the ſteam contained in the chamber to
" which it belongs, and another valve
" having then paſſed the weight, the
" ſteam acts upon it as it had done upon
" the other, and keeps up an uniform
" motion in the wheel.

" The advantages of this particular
" conſtruction are evident. It gives the
" means of producing rotative motions
" of all kinds by ſteam, and by the
" equality

"equality of its velocity is better
"adapted to many purpoſes than thoſe
"engines, which have a reciprocating
"or alternate motion. In point of the
"power gained from a given quantity of
"ſteam, it has all the advantages of the
"reciprocating ſpecies, as the ſteam-
"veſſel is kept uniformly hot, and the
"ſteam is condenſed in a diſtinct veſſel
"in the ſame manner as in the other."

Here is moſt indiſputably a very great invention, and much merit is to be acknowledged in the author. But the difficulty of the execution muſt certainly be much greater than the ingenious inventor apprehended.

The circular channel of ſuch a nice exactneſs, and weight to fit it ſo as to let no ſteam eſcape, are not the only difficulties. What materials can be produced which will make this laſt for any conſiderable

derable time, without being worn by the prodigious friction of the weight, ſo as not to ſtand in need of perpetual repair? For if this wheel is to produce any force great enough to become of real advantage, it muſt doubtleſs be of a conſiderable magnitude; and the weight in continual rotation within, muſt alſo be conſiderable, otherwiſe the mechaniſm will be of little ſignification: I ſhall only add, if however it is really practicable, the invention is beautiful.

Having thus deduced the engine from its firſt invention, with its gradual improvements up to the preſent time, I ſhall offer a full deſcription of my own plan, and the principles on which it is founded; but as a previous preparation for this, I ſhall firſt point out the defects of the preſent method.

Art never ſtept cloſer in the tracts of nature than by the mechaniſm of this engine; and of all contrivances this ſurely carries away the prize of honour in reſpect of invention: For here life is imitated; and, the operation of the machinery, ſet into action by fire, ſeems to come the neareſt of all other mechanical movements to the principles of animal motion. However, ſo imperfect are human inventions, that there will ever be room for farther improvements.

Though the lever of all other mechanical powers is attended with the leaſt friction, yet here in the Steam-Engine, as applied to the purpoſe of pumping, it has its inconveniencies; namely, that ſince the end of the lever to which the pump rods are ſuſpended muſt be loaded with a ſufficiency of weight to force down the pumps and to raiſe the piſton in the cylinder, that weight conſequently muſt be raiſed again by the power of the deſcending ſtroke of the engine, and naturally muſt deduct from the power (applied to the raiſing up of the pump) by the whole amount of the weight appending: thus for example; ſuppoſe the deſcending ſtroke of the piſton into the cylinder be computed fourteen tons, and the weight appending to the pump rods on the other end of the lever be about ſix tons (as it is in the engine to which this improvement is compared) the neat produce of the power will but remain eight tons out of the fourteen. This is an impediment which moſt certainly is wiſhed to be removed.

In the ſecond place, although the lever be ſimple in its motions, yet in large engines it muſt be exceedingly heavy; and its tremulous alternate motion is apt to ſhake the foundation, ſo as to occaſion a conſtant repair both of the engine and the whole building; which is another inconvenience that ſtands in need of a remedy.

And thirdly, if we examine the parts that conſtitute the *primum mobile* of this engine; namely, the fire, the water and the produced ſteam, we ſhall find a conſiderable field for amendments.

In the firſt place, when the ſteam generates faſter than what ſupplies the cylinder, the boiler is either in danger of burſting, or elſe the ſteam forces its way through the puppet clack (provided for that purpoſe) and becomes loſt.

It is frequently a misfortune with men of genius, that they dwell too much on particular parts without viewing the whole acting together in conjunction; hence they often deſcend to become laborious in trifling reſearches, but remain ſuperficial in matters of greater conſequence; and the vain ambition of being thought learned in the eye of the world, has ſunk many a man of great parts into a pedant, and given riſe to fine-ſpun theories and unprofitable ſpeculations. With reſpect to the affair before us I ſhall only obſerve, that though we have had many learned diſſertations on the properties of ſteam, and which ſeems now to be determined to be 13,000 times rarer than the water it is extracted from, and that it is either one-tenth ſtronger or weaker than the common atmoſphere; yet with humble ſubmiſſion I hold all ſuch kind of calculations to amount to very little more than (in the phraſeology of Dr. Swift) extracting ſun-beams out of cucumbers.

If we draw however our obſervations from the nature of things and from facts, we may at any time be convinced that the ſteam of boiling water may be augmented by fire to ſuch a degree, as to burſt a veſſel ſtrong enough to ſuſtain three or four common atmoſpheres; for although boiling water can only arrive to a certain degree of heat, yet the ſteam therefrom produced may be forced to various degrees of power; and all the property of ſteam or vapour, from which we may hope to derive any benefit for the preſent purpoſes is, that the ſteam, the more it is expanded and rarefied, the completer will be the vacuum reſulting therefrom, in proportion as this rarefied vapour is refrigerated by a ſudden cold.

Hence we find by experience, that engines work in winter with a greater degree of force than they do in ſummer; becauſe not only the vacuum in the cylinder is more perfect by the refrigeration, but the cold atmoſphere acts with a greater degree of preſſure upon the piſton:

moreover, ſince ſteam is nothing but rarefied particles of water uniformly intermingled with rarefied elaſtic air expanded by fire, it follows, the more vent it has to aſcend, the more ſteam muſt be generated from the continued heat of the fire.

Hence it muſt evidently appear, that if the ſteam could get a continual vent without being loſt, but always reduced to ſervice, the power of the engine would in conſequence be greatly increaſed, without increaſing the quantity of fuel; beſides, that comparatively no accidents need be feared with reſpect to the mechaniſm of the engine.

All the inconveniencies I have mentioned are not only removed, but many other advantages are demonſtratively obtained by the improvement here offered, which I ſhall beg leave here to explain, agreeable to the annexed plan.

A deſcription of the various parts of the improvement, as far only as they differ from the common engines now in uſe.

The principle of this improvement in the general conſiſts in the engine having two cylinders; into which the ſteam is let alternately to aſcend, by a common regulator which always opens the communication of the ſteam to the one, whilſt it ſhuts up the opening of the other, by which the engine is in a continual action of power. For the piſton rods (by means of a wheel fixed to an arbour) are kept in a continual aſcending and deſcending motion, whereby they move the common arbour, to which is another wheel affixed moving the pump rods, in the ſame alternate direction as the piſton rods, by which continual motion the pumps are kept in perpetual action.

Fig. I. *is a ſection of the principal part of the engine.*

A. A. are two ſteam-cylinders, which by means of the ſteam or throat-pipes in an angular form B. B. have a communication with, and are fixed to the boiler C; by which the ſteam is alternately admitted into either of theſe cylinders by the common regulator D, which is farther explained in Fig. III. E. E. the piſton-rods, which being moved up and down by the interchangeable action of the ſteam and the atmoſphere, are confined to a ſtrong wheel F, by ſtrong iron chains G. G. and ſo fixed, that the ends of one of the chains are faſtened at the tops of both rods, and the other chain at bottom of the ſame rods, coming both in a contrary direction to each other round the wheel, as g. g. and h. h. and to keep the rods ſteady in their motion with the wheel, as Fig. IV. expreſſes.

Fig. II. *exhibits a ſide view of the motion of the piſton rods and the motion of the pump rods, exactly correſponding to each other.*

A. the cylinder; E. the piſton rod; F. the wheel; and G. G. the chain as before. H. the common axle; I. the wheel which works the pumps, conſtructed the ſame as the other; K. the rods, being divided ſo that each of them may work different pumps, the lifting and forcing; by which the force applied will be the more equally divided, that the action of the engine may become the more uniform.

Fig. III. *exhibits the common regulator.*

A. the ſteam-mouth to one of the ſteam-cylinders; B. the other mouth; C. the common regulator, which alternately ſhuts one, whilſt it opens the other.

Fig. IV. *a view of the edge of the wheel.*

A. A. A. A. the grooves for the chains; B. B. the grooves for the rods.

Fig. V. *explains the manner that the ſame mechaniſm which moves one injecting cock, may move with the greateſt accuracy the other likewiſe; ſo that they are alternately opened and ſhut.*

A. the deſcending cold water pipe; B. B. the pipes into the cylinders; C. the part opened or ſhut by the working-beam, which, by means of the mechaniſm E. alternately opens and ſhuts the cocks.

Fig. VI. *is a ſection of the boiler, ſhewing how it may conſtantly ſupply itſelf without the aid of any one, or the inconveniency of ſtopping the operation of the engine—by which alſo there will be no neceſſity of gauges.*

A. is an apartment in the boiler, into which from the ciſtern the water from the injection pipe is let. This apartment is provided with a buoy cock C. at the bottom, to let into the boiler as much water as ſhall be requiſite to keep the boiler to a determined fullneſs. D. the buoy ſwimming on the ſurface of the boiling water in the boiler. B. is a tube to let out of the ciſtern the ſuperfluous water emitted from the ejecting pipe.

Fig. VII. *a farther explanation of the buoy cock in the boiler.*

A. the cock which is opened by the buoy B. floating on the ſurface of the boiling water, and which cock will ever open as the buoy ſinks beneath that line determined; by which there will be let in gradually as much water, as ſhall be conſumed by the ſteam, and thus always preſerve the determined quantity.

From this deſcription, we may demonſtrate an engine upon the preſent plan to have the following advantages:

1ſt, The boiler continually ſupplies itſelf with greater exactneſs than it is poſſible by aſſiſtants; for the water coming from the eduction pipes being kept in the receptacle in the boiling water, is always in a ſtate of proper heat to ſupply the boiler by little and little as the ſteam evaporates; ſo that the engine may be kept in work for any length of time, without the leaſt hindrance to the operation.

2dly, As the ſteam has a continual vent either to one or the other of the ſteam-cylinders, it muſt follow, that the generation of ſteam muſt be greater than uſual, and more eſpecially as the boiler will ever have the ſame quantity of boiling water; hence we derive thoſe advantages, that neither will there be any ſteam loſt, nor can there, from this equality of action, be any danger of accidents; but when once the engine is regularly ſet to work, the operation will proceed uniformly by its own mechaniſm, without any other aid but what is neceſſary for managing the due proportion of fire.

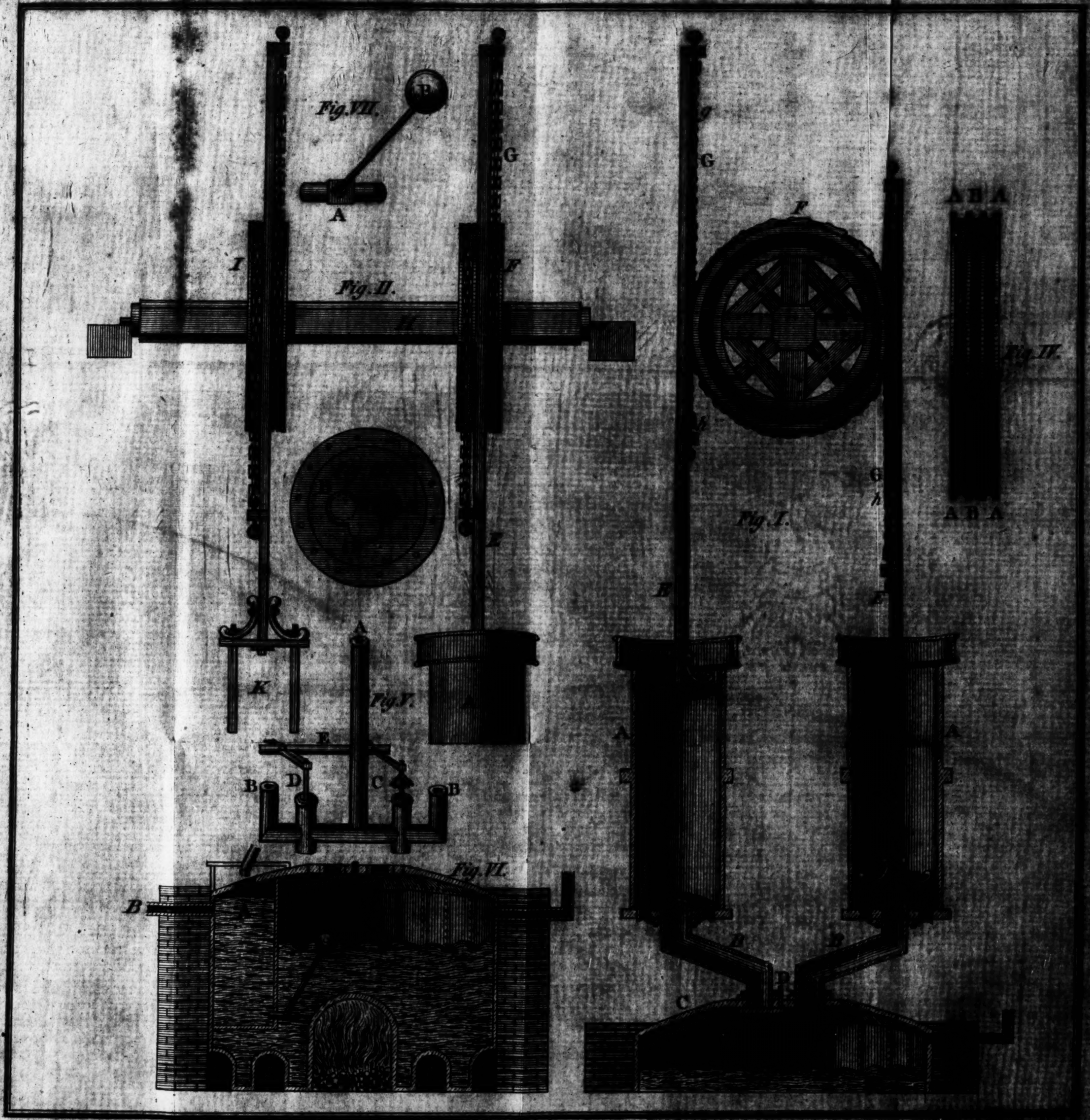
3dly, Since this engine has two ſteam-cylinders, into either of which the ſteam is admitted, it muſt follow, that every motion of the mechaniſm is produced by its own intrinſic force, without the aid of any additional weight.—Moreover, as the cylinders are of an equal magnitude, and their action of equal ſtrength, they muſt exactly counteract each other, ſo that the operation muſt proceed at all times with the greateſt regularity: add to this, that the working-beam may be regulated ſo as to make the ſtrokes ſhort or long, in proportion to the degree of fire.

4thly, An engine upon this conſtruction muſt not only be more compact and ſtronger in its various parts, but the work muſt alſo go on much ſmoother, and without that tremendous trembling and ſhaking of the building, that common lever engines are generally attended with.

5thly, It is demonſtratively plain, that two cylinders muſt have double the ſtrokes, conſequently double the intrinſic force; add to this, that there is no additional weight to raiſe at every ſtroke, as in the common lever engine. Hence we may ſtrike the following compariſon: The Steam-Engine at York-Buildings is computed to have nine ſtrokes per minute, each ſtroke fourteen tons; but the pump end of the lever is loaded with ſix tons, in order to raiſe the ſteam piſton and to force down the pump buckets; conſequently there remains but eight tons intrinſic force of the engine, by which 105 gallons of water are raiſed 102 feet high, amounting in all to 945 gallons per minute. But an engine of the ſame dimenſions on the preſent plan, having two ſteam cylinders, muſt have double the ſtrokes in the ſame given time; and each ſtroke as before, being of fourteen tons power, and that without any deduction of the additional weight commonly made uſe of; the calculation will ſtand thus; 8 : 105 :: 14 : 183¾ gallons per ſtroke; and ſince there muſt be eighteen ſtrokes in a minute, it will amount to 3307 gallons of water, raiſed to 102 feet as before, which is more than treble the quantity of the former. Now making the greateſt allowance poſſible, either for friction or the benefit of the additional weight here deducted, let three tons, or 39⅜ gallons per ſtroke, amounting to near 709 gallons in a minute, be ſubſtracted from the above 3307, remain 2598 the neat produce, being exactly ¾ above double the effect of the common engine.

Theſe are the outlines of the principles of the plan, with a rough calculation to demonſtrate the many advantages which an engine of the propoſed conſtruction muſt inevitably have over thoſe now in uſe. And as I have offered it without reſerve or ſelfiſhneſs, I reſt aſſured it will be received with a candour adequate to ſuch motives.

A deſcription of every minutia of the mechaniſm, and the proportion of its various parts, I have omitted here as wholly unneceſſary; as that muſt depend upon the magnitude of the engine, the ſituation of the place, and the purpoſes it is intended for. On that head I have only to obſerve, that I am very ready to delineate every part of the engine in a due proportion, with requiſite remarks on the operation, for the benefit of ſuch proprietors as may honour me with their commands; and am ſanguine enough to believe, that my knowledge and capa-



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city will enable me to give them the fulleſt ſatisfaction.

But whilſt I declare this, I think it requiſite to diſcharge myſelf from any ſelfiſh views of interfering with the particular profeſſion of any man, or leſſening his merit gained by long ſtudy, experience, and expence; nor ſhall I hope to be underſtood, that I have meant to throw out prejudices againſt Mr. Watt's improvement: The reader will eaſily perceive that there is not the leaſt ſimilarity in our plans; and that the one could not poſſibly have been ſtolen from the other. But ſhould Mr. Watt's improvement of the Lever-Engine prove in practice with every advantage the ingenious author has propoſed, it is plain that no engine is more adapted to his improvement than that on the preſent conſtruction with two ſteam-cylinders; and an advantage to increaſe the power from ſeven pounds to twelve for every ſquare inch, muſt make the engine amazingly powerful.

Laſtly, it well deſerves our notice, that this kind of mechaniſm is extremely well adapted for many other purpoſes beſides that of raiſing water; as a Steam-Engine upon this principle might eaſily be conſtructed ſo as to forge, ſtamp, flat, ſaw, grind, and perform many other capital operations in ſuch places where no wind or water-mills could be erected: beſides, there are many mechanical inventions for tranſporting of goods both by land and water, of great importance to ſociety, both on account of cheapneſs and expedition, hitherto not put into practice, to which a Steam-Engine might on this principle be applicable; which I ſhall at another time, if this meets with approbation, take an opportunity of ſubmitting to the inſpection of the public. But ſhould Mr. Watt's rotative Steam-

Engine (of the ſecond kind) anſwer in practice equal to the merit of its invention, it will doubtleſs be attended with a prodigious advantage to ſociety, and in my opinion, from its circular motion, muſt prove greatly ſuperior to the principles of the plan here offered; which however muſt be left to experience to determine.

To conclude, I muſt beg to be acquitted of that kind of vanity by which men of narrow minds are led away into ſelf-conceit, ſuppoſing themſelves ſuperior to their cotemporaries; and thence, with eyes of envy, tremble at every ſtep, leſt any one ſhould rob them of their little honour or pelf, the only incitement to little men of becoming uſeful.

True ingenuity is not obtained by practice or long experience—it is a quality inherent, the gift of nature, but ſhines in proportion as it is poliſhed by the labours of thouſands before us. Therefore, however eligible my plan may appear, I am well aware that no human invention can arrive to perfection, and that there will ever be room for improvements *ad infinitum*.

Truth, like the brilliant ſun, is not at all times viſible; and it is but right it ſhould be ſo; otherwiſe, the race of man is ancient enough to have come at ſuch a *ne plus ultra* in knowledge, that neither we nor our poſterity would have any thing to invent or to feed our ambition with.

The deeper we dive into the nature of things, the more we diſcover infinity of wiſdom before us, beyond the reach of our comprehenſion, like travelling in the boundleſs firmament;—and looking back to all the acquired knowledge of a Newton,

ton, it amounts, with all our wonted pride, to a mere atom, in compariſon to the Mundane ſpace and all its endleſs contents! Fallibility is inherent to human nature, and let no one be aſhamed of it. He certainly gives the greateſt proof however of his underſtanding and candour, who is moſt open to the conviction of truth, and who is moſt ardent to point it out to others; and he indiſputably proves himſelf a dutiful member of ſociety, who liberally diſplays his little mite of knowledge for the inſpection of thoſe who may reap benefit from it.

FINIS.